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September 17, 1999

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APPLICATION NUMBER: ***60/100,632***
FILING DATE: ***September 16, 1998***
PATENT NUMBER:
ISSUE DATE: ***00, 0000***

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H. L. JACKSON
Certifying Officer

Please type a plus sign (+) inside this box → [+]

Docket Number: 1466/1

PROVISIONAL APPLICATION FOR PATENT COVER SHEET (Large Entity)

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53 (c).

INVENTOR(S)/APPLICANT(S)		
Given Name (first and middle [if any])	Family Name or Surname	Residence (City and either State or Foreign Country)
David	Medved	Jerusalem, Israel
Leonid	Davidovich	Jerusalem, Israel

☐ Additional inventors are being named on page 2 attached hereto

TITLE OF THE INVENTION (280 characters max)

Wireless Optical Communications Without Electronics

CORRESPONDENCE ADDRESS

Direct all correspondence to:

☐ Customer Number [ ] → Place Customer Number Bar Code Label here

OR

☐ Firm or Individual Name	Mark M. Friedman				
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Address	2001 Jefferson Davis Highway - Suite 207				
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Country	U.S.	Telephone	(703) 415-1581	Fax	(703) 415-4864

ENCLOSED APPLICATION PARTS *(check all that apply)*

☒ Specification — Number of Pages: 5

☒ Drawing(s) — Number of Sheets: 9

☐ Other (specify)

METHOD OF PAYMENT OF FILING FEES FOR THIS PROVISIONAL APPLICATION FOR PATENT *(check one)*

☐ A check or money order is enclosed to cover the filing fees

☒ The Commissioner is hereby authorized to charge filing fees or credit any overpayment to Deposit Account Number: 06-2140

FILING FEE AMOUNT: $75.00

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government

☒ No

☐ Yes, the name of the U.S. Government agency and the Government contract number are. _____

Respectfully submitted,

SIGNATURE _____ DATE September 8, 1998

TYPED or PRINTED NAME Mark M. Friedman REGISTRATION NO. (if appropriate) 33,883

TELEPHONE (703) 415-1581

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P19LARGE/REV04

PROVISIONAL APPLICATION FOR PATENT

Inventor: David Medved, Leonid Davidovich

Title: Wireless Optical Communications without Electronics

DISCLOSURE

1. Background

Wireless Optical Communications Systems have been utilized for transmission of high speed data over the past two decades. An example of a typical system is given in Fig. 1 for the Universal wireless infrared network concept originally introduced by JOLT. The essential idea uses either a hard wire or a fiber optic interface to convert messages coming from an network interface unit NIU or a PBX into appropriate electronic signals which are then utilized to modulate an LED or laser. This transmitter contains pulse shaping circuits. driver circuits (and temperature stabilization in the case of laser systems). The bears which leaves the system is thus modulated with the intelligence which came out of the network interface unit. Conversely, a beam which is received in such a duplex system is demodulated by a photo diode amplified by a FET or transimpedance amplifier chain and then presented back to the network interface unit either through fiber optic conversion or directly as a hard wire connection. In either case it is necessary to utilize a large amount of electronic circuitry as well as electro-optical elements such as lasers, LEDs photo diodes and avalanche photo diodes adding to the cost and complexity of the unit.

2. General Description

In this patent application we propose a design and fabrication of airlink transmitters and receivers without any electronics (the Photonic Airlink Transmitter - PAX and the Photonic Airlink Receiver - PAR).

The basic idea is to utilize the fiber output from either single mode or multi mode fiber properly focused and projected through space (FIG. 2).

It is the inventor's understanding that AT&T has once patented a disaster recovery device for those situations where fiber cables were cut and there was an emergency requirement to bridge a small gap of a few meters, while the cable itself would be repaired.

This disclosure differs from the AT&T patent as follows (see FIG. 2).

a) The use of an array of multiple lenses to increase the power gathering capability of the receiver with big improvement in range. We estimate the range of this system to be more than 100 x range of the AT&T solution.

b) The use of large core diameter fibers (>microns) with large N.A. to achieve collection efficiency greater than 50% per channel or alternatively to use f.o. pigtails with GRIN lenses (FIG. 3). These GRIN lens pigtails have been used in the past to increase coupling efficiency of laser diode into a small fiber: the proposed use herein is the first use of such devices in this application.

c) The use of a fiber optic combiner to provide additive photonic signals.

d) The use of large area MIS photodiodes integrated with amplifiers compatible with the exit fiber of the combiner.

e) The use of multiple lens arrays at the receiver (and if necessary at the transmitter) minimizes or completely eliminates scintillation losses of signal.

3. Application to DWDM

The present invention may also be applied to Wireless Transmission of WDM Signals to OC-192 level and beyond.

DWDM (Dense Wavelength Division Multiplexing) has experienced phenomenal growth in the past four years. It is a highly cost-effective way to add bandwidth. All major carriers have experienced fiber exhaust and have turned to DWDM as a solution. Companies like Lucent Technologies and Ciena have announced systems capable of carrying up to 400 Gbps of traffic per individual fiber at long distances (64 channels of 2.5 and I 0 Gbps mixed). Until recently it did not appear that there would be a short haul (Last Mile) market for WDM, and certainly not a need for wireless transmission of WDM signals which is an absolute impossibility for the radio/RF carrier.

However, there now appear to be mass markets developing for short haul WDM, whether in FTTC or similar applications.

Consider Fig. 4 which is a block diagram of a proposed configuration to achieve wireless WDM. The transmitter (PAX) and receiver (PAR) are similar to the configurations described in Fig. 2. There are two possible inputs from the terminus of the fiber cable carrying the WDM signals shown here as λ_1 , λ_2....λn where n can be a

number from four to 64. At signal level above 100 μw and for short distance these can be fed directly into the PAX via path A thus eliminating the need for the fiber optic amplifier (FOA). (See also Fig. 2 specs.). For longest distance the FOA is needed. The PAX projects the beam into the atmosphere for reception at the PAR. A large core diameter WDM (which is today available from companies like ADVA or JDS Fitel (JDS is building a custom WDM to JOLT specification with large core fiber) connects to the PAR and demultiplexes the various wavelengths. The output fibers should also be large core (100 microns or higher), Ale photodiode receivers therefore need to be at least this size or preferably higher so that standard pin silicon cannot be used.

Instead we suggest use of MIS photodiodes integrated with high speed preamplifiers as shown by the devices in Fig. 5. The n channels of electronic high speed data are processed in the usual way to recover the information as required.

To extend the receiver sensitivity while maintaining speed, custom devices are being designed between JOLT and Vitesse which will allow us to replace the MIS device with GaInAs APD on the pad provided. Such devices extend sensitivity by a factor of ten without sacrificing speed and allow wireless WDM transmission to the Last Mile (1.6 km).

4. Wireless Remote Antenna Applications

The design and fabrication of transmitters and receivers without electronics for wireless transmission of data was discussed in general above.

In Fig. 2, the Fiber output/input from a Network Interface Device (the NIU in Fig. 1) is projected as a beam into the air and captured at the receiver end of the wireless Remission path. The NIU as shown is typically a switch,

hub, bridge, router or similar device which is part of the customer's network. The data format implicitly was high speed binary digital.

There exists today a market for sending a large number of analog signals multiplexed on a carrier at 1-4 GHz range to a remote antenna on fiber optics. Companies like Foxcom and Ortel are providing these RF-Fiber. JOLT proposes to use the Foxcom transmitter/receiver modules as the equivalent of NIU and provide a wireless connection from the base station to the remote antenna replacing the need to deploy fiber.

FIG. 1

Universal Wireless Infrared Network (UWIN) Equipment Block Diagram

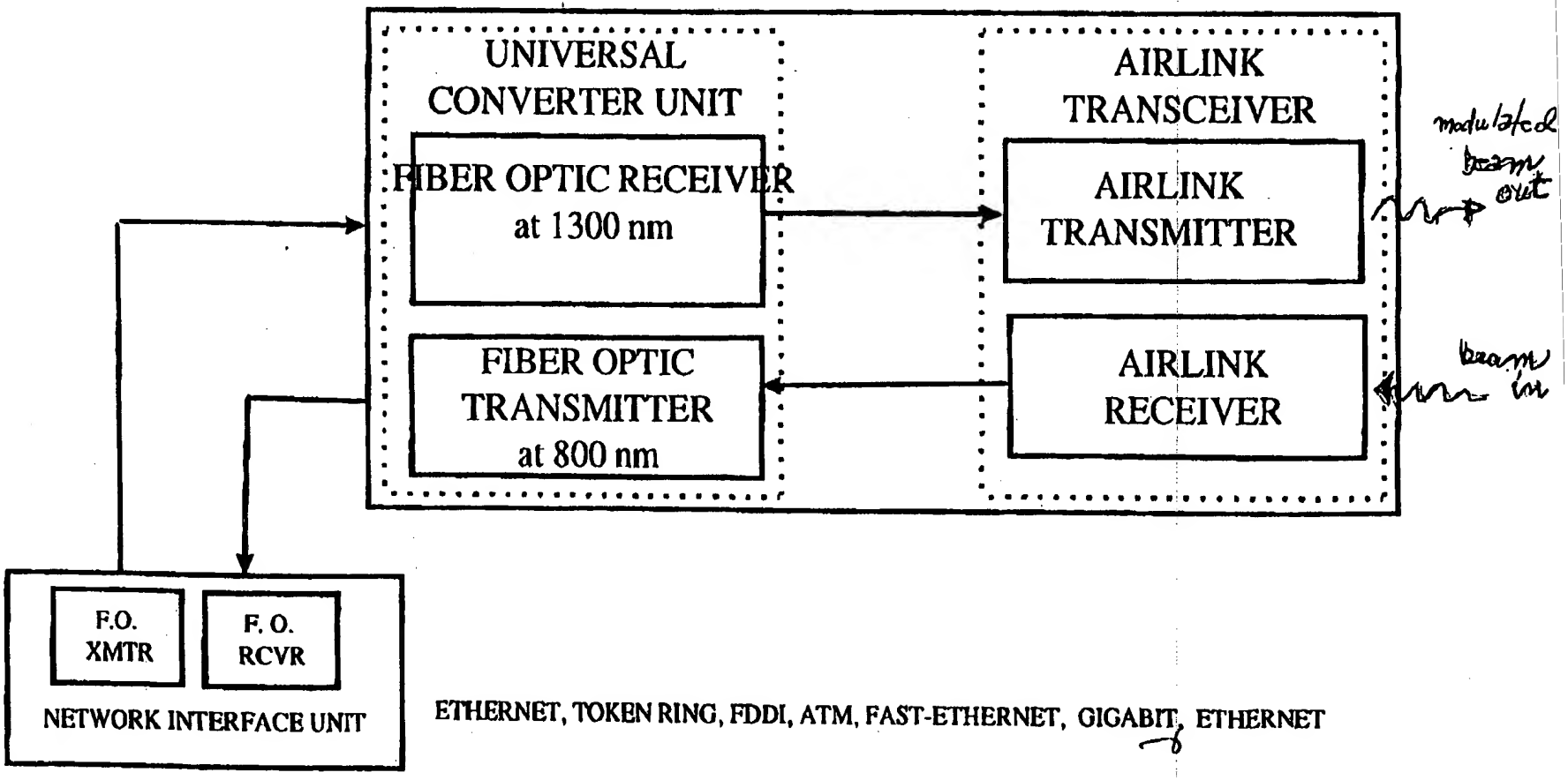
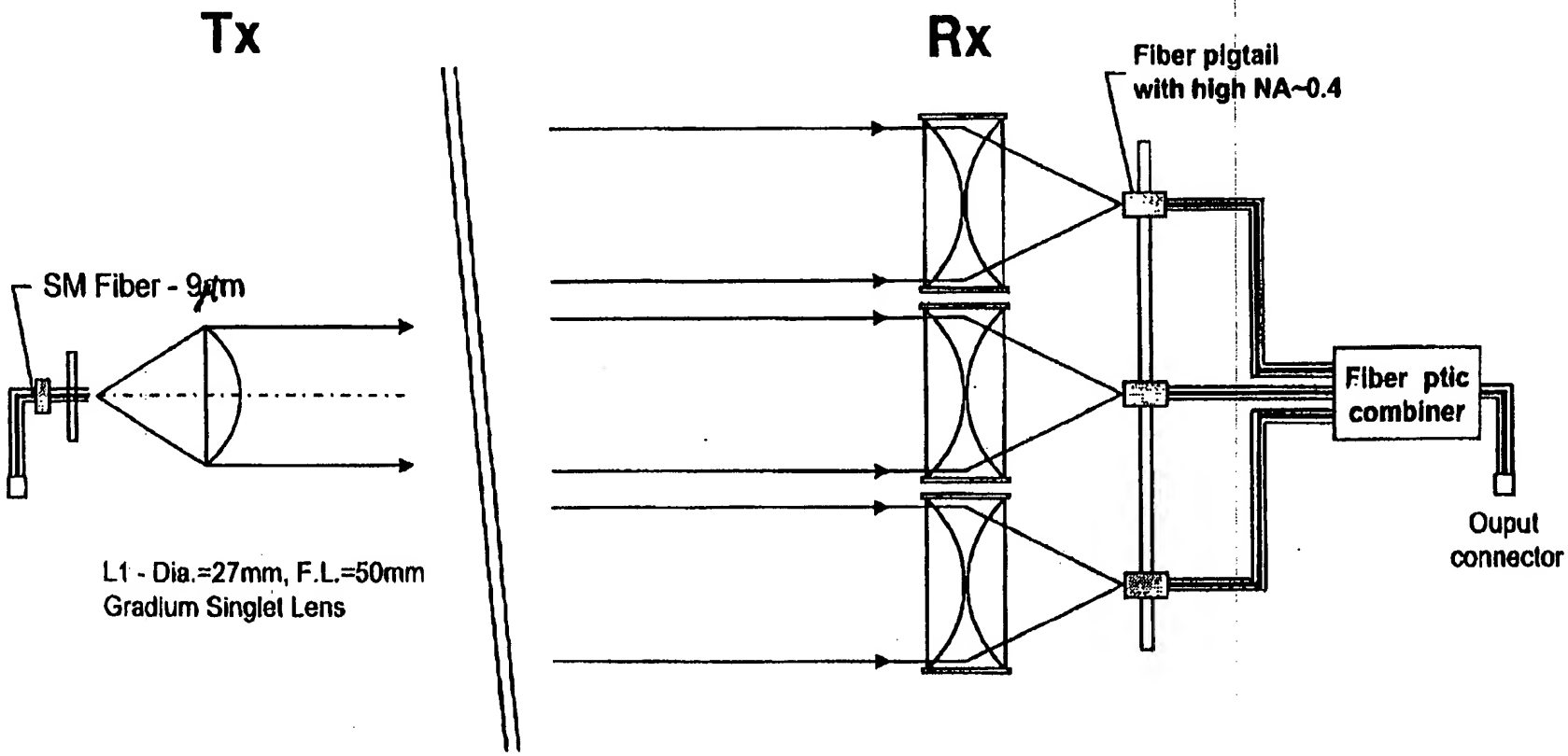


FIG. 2

Wireless Interconnection without Electronics

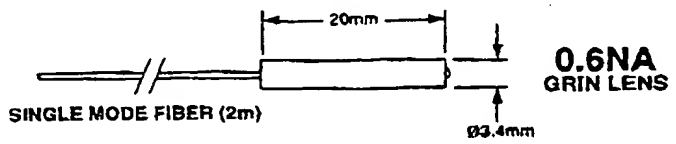
PAX
(Photonic Airlink Transmitter)

PAR
(Photonic Airlink Receiver)



06/09/98

LASER PIGTAILS: SINGLE MODE



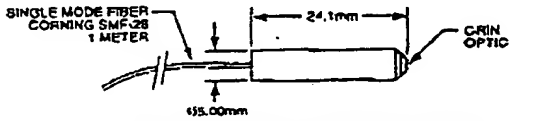
WORKING DISTANCE: 0.6mm
NOTE: PLEASE CHECK LASER-TO-WIND W DISTANCE SPECIFICATION FOR THE LASER DIODE TO BE COUPLED. THE LASER DIODE WINDOW MAY NEED TO BE REMOVED TO ACHIEVE MAXIMUM COUPLING EFFICIENCY.

► Maximum Power 100mW

Thes single mode laser pigtails simplify the task of adding a single mode fiber pigtail to a laser diode. By prealigning a high NA (0.5) GRIN optic to a single mode fiber we have reduced the alignment process to one step.

ITEM#	WAVELENGTH RANGE	FIBER
51-4224	780 - 870nm	3M FS-SN-4224
5113-SMF	1300 - 1350nm	Corning SMF-28
5115-SMF	1500 - 1580nm	Corning SMF-28

ISOLATED LASER PIGTAIL: SINGLE MODE



PIGTAILED LASER COUPLING ISOLATORS

An optical isolator is incorporated in this laser to fiber coupling package. The standard model provides more than 40dB (10,000:1) of isolation with the double stage device providing more than 60dB (10^6:1) isolation. These mechanically rugged devices, manufactured by Princeton Optics, are built to meet the standards of the telecommunication industry.

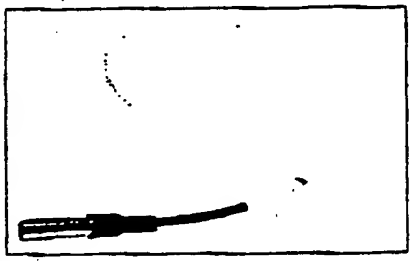
SINGLE STAGE - >40dB

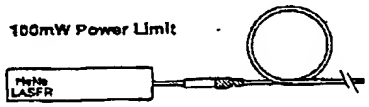
ITEM#	WAVELENGTH RANGE	BANDWIDTH	COUPLING EFFICIENCY
4213SA	1310nm	±20nm	40 - 50%
4215SA	1550nm	±20nm	40 - 50%

DOUBLE STAGE - >60dB

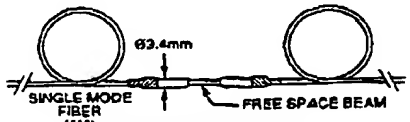
ITEM#	WAVELENGTH RANGE	BANDWIDTH	COUPLING EFFICIENCY
4213DA	1310nm	±20nm	35 - 40%
4215DA	1550nm	±20nm	35 - 40%

FIBER COLLIMATORS





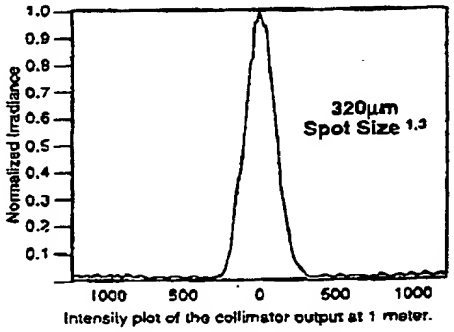
FIBER INPUT



COLLIMATOR PAIR

► Ø1.8mm Clear Aperture
► AR Coated All Surfaces
► Input Coupler
► Output Collimator

ITEM#	OPERATING WAVELENGTH [2]	FIBER	END PREPARATION
50-630	630nm	FS-SN-3224	None
50-630-FC	630nm	FS-SN-3224	FC Connector
50-820	820nm	FS-SN-4224	None
50-820-FC	820nm	FS-SN-4224	FC Connector
50-980	980 / 1060nm	FS-SC-5624	None
50-980-FC	980 / 1060nm	FS-SC-5624	FC Connector
50-1310	1310nm	SMF-28	None
50-1310-FC	1310nm	SMF-28	FC Connector
50-1550	1550nm	SMF-28	None
50-1550-FC	1550nm	SMF-28	FC Connector

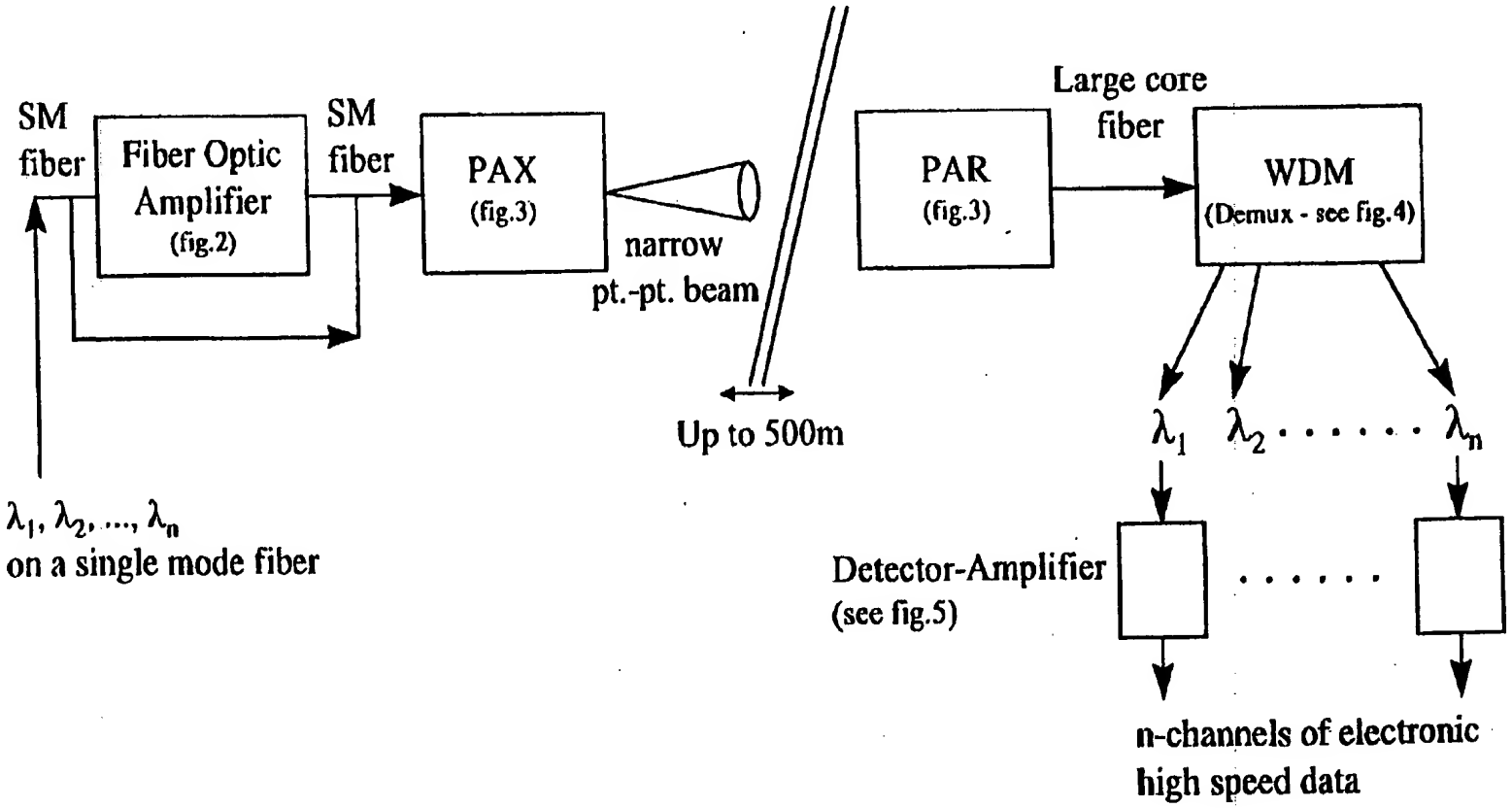


Intensity plot of the collimator output at 1 meter.

1. Model 50-630, measured with HeNe laser and FS-SN-3224 (page 113) fiber.
2. These fibers typically operate 50nm below and 200nm above the operating wavelength.
3. Full width $1/e^2$ spot size.

FIG. 4

Wireless DWDM (Dense Wavelength Division Multiplexing) System



VITESSE
SEMICONDUCTOR CORPORATION

FIG. 5

Photodetector/Transimpedance Amplifier Family for Optical Communication

Data Sheet
VSC7810

Table 1: Electro-Optical Specifications(1)

Symbol	Parameter	Min.	Typ.(2)	Max.	Units	Conditions
V_{SS}	Supply Voltage	4.5	5.0	5.5	V	
I_{DD}	Supply Current	13	26	40	mA	
PSRR	Power Supply Rejection Ratio	35	----	----	dB	f = 1 to 40 MHz (Includes External Filter)
λ	Wavelength	700	840	850	nm	
F_c	Low Frequency Cutoff	----	----	1.8	MHz	-3db. P(5) = -15 dBm @ 50 MHz
BW	Optical Modulation Bandwidth	850	1200	1300	MHz	-3db, P = -15 dBm @ 50 MHz (3)
S	Sensitivity	-22	-25	-27	dBm	1.063Gb/s BER 10^{-12} (3)
R_o	Single Ended Output Impedance	25	----	60	Ω	
V_d	Differential Output Voltage	0.35	0.52	0.65	V	P = -4.5 dBm, R_{load} = 100 Ω differential
R_d	Differential Responsivity	0.8	2.2	----	mV/μW	R_{load} = 100 Ω P = -15 dBm @ 50 MHz
V_{dc}	Output Bias Voltage	1.2	1.5	2.5	V	
ΔV_{dc}	Bias Offset Voltage	----	40	150	mV	
NEP_o	Input Noise Equivalent Power	0.35	0.45	0.93	μW rms	P = 0mW (4)
V_{no}	Output Noise Voltage	0.55	0.66	0.75	mV rms	P = 0mW (4)
DCD	Duty Cycle Distortion	----	1.5	4.5	%	P = -4.5 dBm
I_{out}	Output Drive Current	2.5	----	8	mA	
PDJ	Pattern Dependent Jitter	20	40	60	ps	P = -4.5 dBm +/-10% Voltage Window
----	Optically Active Area	----	100	----	μm	Diameter
PPJ	PP Jitter	120	160	200	ps	P = -4.5 dBm
T_r	Rise Time	310	355	400	ps	20-80% P = -4.5 dBm
T_f	Fall Time	280	325	370	ps	20-80% P = -4.5 dBm

Notes: (1) Specified over 0°C (ambient) to 70°C (case). See also Note 1 - in section "Notes on Measurement Conditions & Applications" for extended temperature range operation.
(2) Typical conditions 25°C (case) and 5V power supply.
(3) See Note 1 - in section "Notes on Measurement Conditions & Applications".
(4) See Note 2 - in section "Notes on Measurement Conditions & Applications".
(5) P = Incident Optical Power

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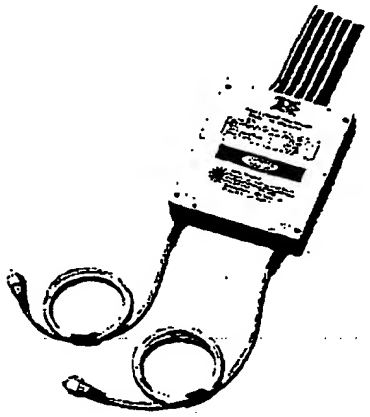
FIG. 6

NEW PRODUCT

OA915 Series Optical Gain Module



Description

The OA915 Series optical gain module is a low noise and high gain Erbium-doped fiber amplifier designed for single-mode fiber applications in the 1550 nm wavelength region. The board-mountable module delivers consistently high performance by using a 980 nm pump laser diode (LD), an in-line polarization independent optical isolator, a wavelength division multiplexing (WDM) coupler and Erbium-doped fiber. A counter-propagating pump configuration has been chosen and the design has been optimized for both pre-amplifier and booster amplifier applications. The input isolator is optional when a low return loss source is available. Eliminating the isolator improves the noise figure.

The OA915 Series is a fully integrated unit that can be externally controlled to vary the optical gain. Stable pump laser temperature is achieved with the integrated thermoelectric cooler (TEC). Constant pump power is maintained with a built-in backfacet photodiode monitor. A ribbon cable provides electrical connection to the pump laser, TEC, thermistors and monitor photodiodes.

The OA915 can be customized to meet individual requirements. All the common connector types are available as well as pigtail or bulkhead mounting. Monitor taps for input, output and back reflection are easily accommodated. In addition, the amplifier performance, (i.e. gain, noise figure, and output power) can be optimized for specific applications. See the options guide for further information.

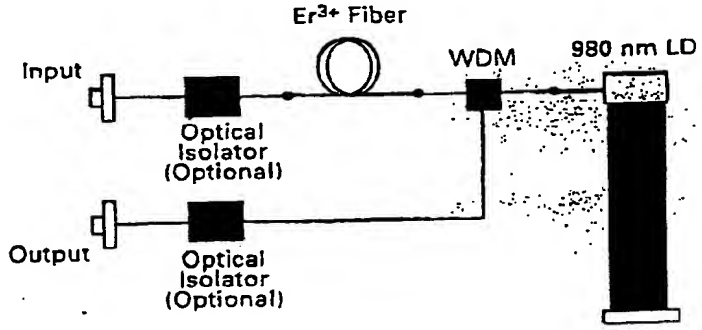
Key Features

- Compact module
- Stable, low noise performance
- High fiber-to-fiber gain
- High saturation output power
- Low polarization dependence
- Low power dissipation
- Single-pumped at 980 nm

Applications

- Telecommunications systems
- Broadband communications
- CATV networks

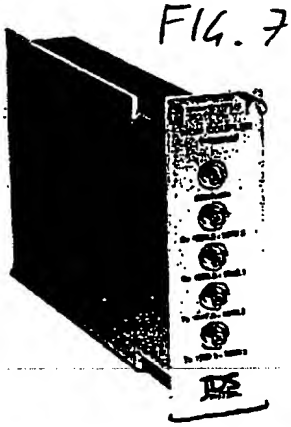
EDFA Block Diagram



JDS FITEL

FIG. 7

WD5555B M/D
Unidirectional Dense WDM
1533/1541/1549/1557 nm



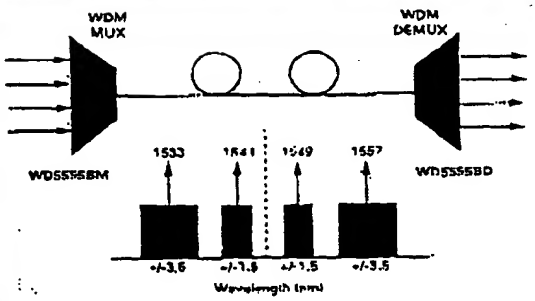
Description

The WD5555B M/D is an advanced product developed for high density multi-channel WDM applications. The design is based on cascaded interference filters with wavelength channel spacing of 8 nm.

Key Features

- Unidirectional
- Low insertion loss
- High isolation
- Low PDL

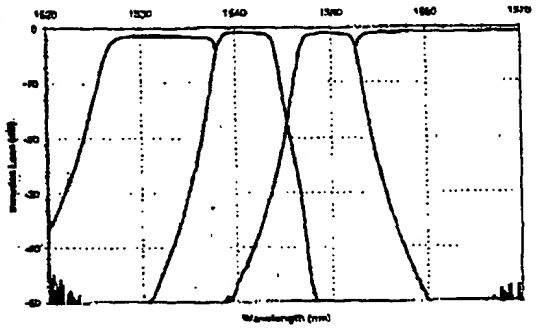
Configuration



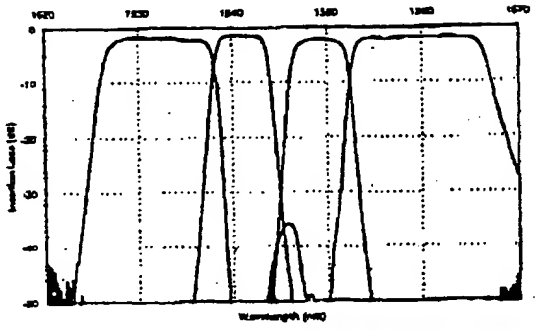
Applications

- 4 wavelength dense WDM
- High capacity transport systems
- Optical network

4-Channel WDM Mux - Optical Spectrum



4-Channel WDM Demux - Optical Spectrum



JDS FITEL

JDS FITEL

FIG. 8

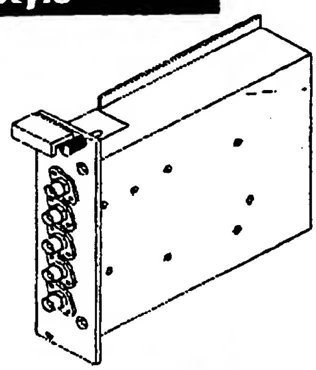
ISO 9001

Specifications

		Multiplexer	Demultiplexer
Operating wavelength	1533±3.5 nm	transmit	receive
	1541±1.5 nm	transmit	receive
	1549±1.5 nm	transmit	receive
	1557±3.5 nm	transmit	receive
Insertion loss[1]	Multiplexer	<2.0 dB	
	Demultiplexer	<2.5 dB	
	end-to-end	<4.5 dB	
Isolation		>25 dB	
Directivity		>65 dB	
Return loss		>45 dB	
Optical power		+20 dBm maximum	
Polarization sensitivity		<0.25 dB	
PMD		<0.1 psec	
Dimensions (WxHxD)[2]		1.38 x 5.07 x 5.04 inches	
Temperature		0 to 50°C	
Connectors		FC/PC	

1. Including common connector as measured against reference.
2. Please see JDS FITEL shelf product (the CS1000) which holds up to 12 cassettes.

Cassette Package Style



Ordering Information

Indicate your application requirements by selecting one feature from each configuration table. For more information on this or other products and their availability, please contact your local JDS FITEL sales representative, or JDS FITEL directly at (613)727-1303, or by fax at (613)727-8284 or via e-mail at sales@jdsfitel.com.

A.	Configurations	Check One
1.	Multiplexer	
2.	Demultiplexer	

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FIG. 9

Data Sheet
VSC7810

Photodetector/Transimpedance Amplifier Family for Optical Communication

Features

- Integrated Photodetector/Transimpedance Amplifier Optimized for High Speed Optical Communications Applications
- Integrated AGC
- Fibre Channel/Gigabit Ethernet Compatible
- High Bandwidth
- Low Input Noise Equivalent Power
- Large Optically Active Area
- Single 5V Power Supply

Part Number	Data Rate	Bandwidth (MHz)	Input Noise (μW rms)	Optically Active Area (μm diameter)
VSC7810	Full Speed: 1.25 Gb/s	1200	0.45	100

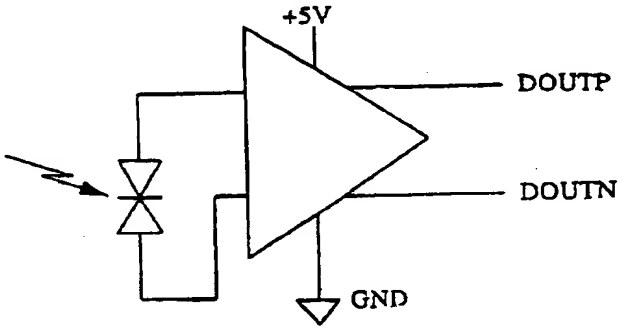
General Description

The VSC7810 integrated Photodetector/Transimpedance Amplifier provides a highly integrated solution for converting light from a fiber optic communications channel into a differential output voltage. The benefits of Vitesse Semiconductor's Gallium Arsenide H-GaAs process are fully utilized to provide very high bandwidth and low noise in a product with a large optically active area for easy alignment. The sensitivity, duty cycle distortion and jitter meet or exceed all Fibre Channel and Gigabit Ethernet application requirements. Parts are available in either die form, flat-windowed packages or in ball-lens packages.

By using a metal-semiconductor-metal (MSM) photodetector with a monolithic integrated transimpedance amplifier, the input capacitance is lowered which allows for a larger optically active area than in discrete photodetectors. Integration also allows superior tracking over process, temperature and voltage between the photodetector and the amplifier, resulting in higher performance. This part can easily be used in developing Fibre Channel Electro-Optic Receivers which exhibit very high performance and ease of use.

VSC7810 Block Diagram

Photodetector/Transimpedance Amplifier



Both DOUTP and DOUTN are back-terminated to 50Ω

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SMALL BUSINESS CONCERN - NEW APPLICATION

Attorney Docket No.. 1466/1

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In RE Application of: DAVID MEDVED AND LEONID DAVIDOVICH

Filed Concurrently Herewith

For WIRELESS OPTICAL COMMUNICATIONS WITHOUT ELECTRONICS

VERIFIED STATEMENT UNDER 37 CFR 1.27
CLAIMING STATUS AS A SMALL ENTITY

To The Commissioner of Patents and Trademarks:

I hereby declare that:

I am the owner of, or an official empowered to act on behalf of, the small business concern identified below:

Name of Concern: JOLT LTD.

Address : 8 HAMARPEH STREET, JERUSALEM 97774, ISRAEL

☐ The small business concern identified above, together with its affiliates, employs fewer than 500 persons and qualifies as a small business concern as defined in 37 CFR 1.9(d) for purposes of paying reduced fees under 35 USC § 41(a) and § 41(b) to the Patent and Trademark Office with regard to the above-entitled invention described in the specification filed herewith.

☐ Rights under contract or law have been conveyed to and remain with the small business concern identified above with regard to the above entitled invention.

☐ If the rights held by the small business concern are not exclusive, each other party having rights to the invention is listed below, and no rights to the invention are held by any party who could not qualify as a small entity under 37 CFR 1.9(f), namely any person who could not be classified as an independent inventor under 37 CFR 1.9(c) if that person had made the invention, or any concern which would not qualify as a small business concern under 37 CFR 1.9(d) or a nonprofit organization under 37 CFR 1.9(e).

Full Name (Party 1) : NONE

Address : _____

Status : ☐ Individual ☐ Small Business Concern ☐ Nonprofit Organization

Full Name (Party 2) : _____

Address : _____

Status : ☐ Individual ☐ Small Business Concern ☐ Nonprofit Organization

I acknowledge the duty under 37 CFR 1.28(b) to file, in this application, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the issue fee due after the date on which status as a small entity is no longer appropriate.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application and any patent issuing thereon.

J. LORCH
Name of Person Signing

Signature

SEPT 8TH 1998
Date

Capacity of Person Signing: CEO

Address of Person Signing : As Above